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The Pattern of Landfill Leachates Pollution in Tidal Waste Land: A Case Study in TPA Basirih, Banjarmasin, Indonesia

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Abstract The main issue in the perspective expectation of tidal TPA (landfill) is about the big potential in polluting the environment. One of the pollutants which caused by the TPA is leachates. The pattern of the pollution dissemination which caused by the TPA is spread evenly/cluster. Pollutans start to spread from TPA at the distance of 0 M up to 200 M without showing that there is a reduction of pollution concentration.The even dissemination of the pollution concentration occurred both in water or soil media. This condition is caused by the factor that the location of this TPA is in tidal area and the soil condition with high porosity of saturated water. The pollutants concentration of the river which caused by leachates, is relatively spread evenly on the observation area either when it's tide or subsided. This condition is caused by the tide or subsided flow which continuosly happens twice a day which will make the level of water and pollutants mixing is spread evenly.

Keywords Pattern, Dissemination, Leachates, Tidal TPA

1. Introduction

Leachate generated from landfill, is an important source of environmental pollution around the landfill. The increase in municipal waste Banjarmasin reached 1019 m^3 per day and is likely to increase from year to year will increase the production of leachate and the more potential to pollute the environment. The presence of leachate from the landfill has a high risk of contaminating water and soil around the landfill [1]. Leachate contains dissolved organic material, inorganic compounds and metals [2]. The dump has been identified as one of the major threats to water resources and land [3].

The quantity of leachate at the landfill is determined by the intensity of the rain, the effective area of the landfill, evaporation, infiltration / soil porosity and moisture content of litter. As for the quality of the leachate composition determined by the type of waste, the amount of garbage, the amount of water that dissolves landfill waste and operational systems. The purpose of this study to determine the pattern of spread of landfill leachate to the surrounding environment. The pattern of spread of leachate is required in order to attempt leachate management, including the collection, transmission, treatment and discharge of leachate into the environment.

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Production of leachate coming from the liquid contents in the trash because of the decomposition process is also involved rain water into the garbage and litter decomposition dissolving material that accumulates at the bottom of the landfill and seeping through the ground [4]. Contamination occurs due to the continuous leachate seeping into the environment from time to time regardless of the environmental consequences [5]. Landfill conditions in the tidal area further increased the potential for leachate contamination of the environment. The existence of leachate at the landfill must be managed and processed so that it does not cause environmental pollution. To perform the necessary processing of accurate data, a pattern of contamination, quantities and quality of landfill leachate on tidal land.

The tidal condition of the environtment affected the leachates amount and dissemination around the TPA environtment. Tidal water caused the soil to be water-rich. The existence of tidal condition also effected the underground water flow which tend to be up and down / unstable which caused the leachates dissemination to be evenly spread. The dissemination of leachates could spread on the TPA surrounding area by cluster.

The pattern of leachates dissemination in the TPA area is influenced by the flow direction of ground water, ground water velocity, soil porosity as well as the quality and quantity of leachates pollutant [6]. The surface water flow also has a role on the TPA leachates dissemination. Dissemination through the surface water flow is influenced by the TPA infrasctruture which is not sufficient enough.

The dike leakage and leachates leakage is caused by an unappropriate dike. The leachates run-off water is due to the high intensity of rain which could not be accommodated by the Installation of Leachates Management, it is also as the reason of leachates dissemination around the environtmet. The tidal area condition also affected the dissemination pattern of the pollutant.

2. Research Methods

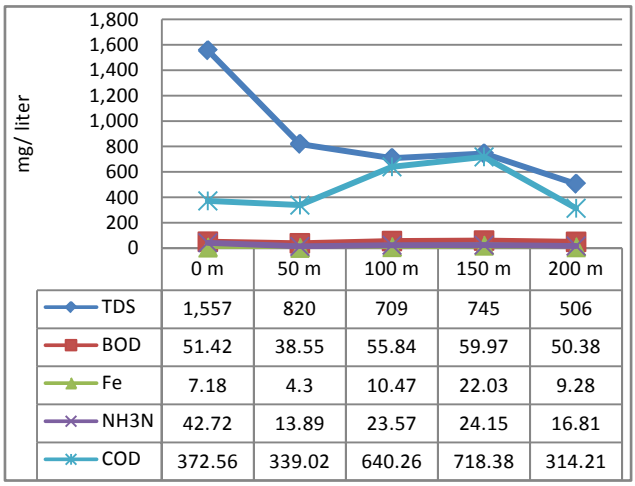
The method used in this study is a survey method. The survey was conducted to measure the distribution of leachate at the landfill area. Measuring the quality of leachate in an area with a certain distance in the area of tide and low tide area. The survey was also conducted on the condition of landfill environment, especially factors tidal surface water, soil type, rainfall and potential flooding. The frequency of sampling done 3 times for the dry season and the third time for the rainy season.

The collected data was in the form of primary and secondary data. Primary data were obtained from a direct interview with the TPA manager, leachates water quality and quantity measurement and an interview with other relevant instantion or agency. In the implementation of primary data collection, it was in the form of leachates quality measurement on the surrounding area. The leachates quality measurement was preceded by creating a well for water sampling. The number of samples taken as many as 72 samples. Measuring the quality of leachate preceded by wells for water sampling. Determination of sample points is done linearly from the source (TPA) with a distance of 0 meters, 50 meters, 100 meters, 150 meters and 200 meters towards the ups and downs direction. While the river water sampling conducted at the point of the flow of the upstream and downstream at the point on the river around the landfill. The parameters of leachates pollutants which observed on the water in this research was Biological Oxygen Demand (BOD_5), Chemical Oxygen Demand (COD), Total Disolved Solid (TDS), Iron (Fe) and NH_3N. While the parameters of leachates pollutants which observed on the ground in this research was P_2O_5, SO_4, dissolved Iron (Fe) and N-HN_4. The observation towards the leachates dissemination was conducted for a year. Primary and secondary data was analyzed and formulated to determine the leachates quality in the surrounding area of TPA Banjarmasin.

3. Results and Discussion

The dissemination of leachates pollutant on the water and soil around TPA.

The leachates dissemination pattern of the tidal TPA was observed on water in a tide and subsided area next to the TPA location. On a tide area, the TDS dissemination was decreased, it was 1500 mg/liter at first and then it decreased until 506 mg/liter at the distance of 200 m. While in other parameters, the leachates dissemination pattern was occurred evenly and less likely to be decreased at the distance up to 200 m. BOD dissemination on a tide area was evenly spread in the range of 38.55 mg/liter to 59,57 mg/liter as well as the COD dissemination in the range of 314,21mg/liter to 718.38 mg/liter. Fe dissemination was also evenly spread in the range of 4.3 mg/liter to 22.03 mg/liter and NH_3N in the range of 13.89 mg/liter to 42.72 mg/liter. Whereas the pH condition on a tide area was in the range of 7.43 to 7.93. For further details about the pollutants dissemination on a tide area, it can be seen on figure 1.



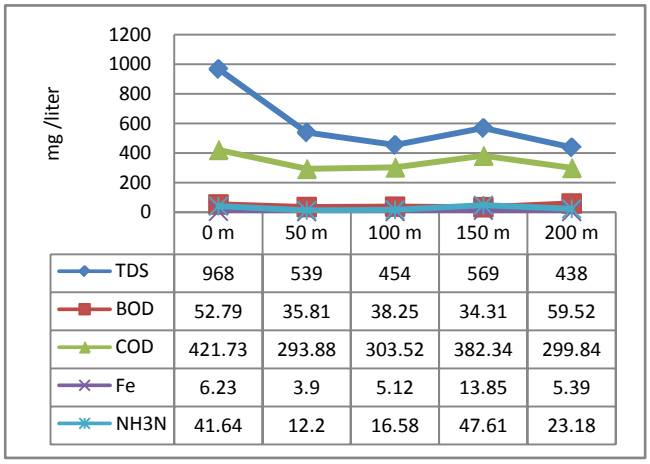
	0 m	50 m	100 m	150 m	200 m
TDS	1,557	820	709	745	506
BOD	51.42	38.55	55.84	59.97	50.38
Fe	7.18	4.3	10.47	22.03	9.28
NH3N	42.72	13.89	23.57	24.15	16.81
COD	372.56	339.02	640.26	718.38	314.21

Figure 1. The Patt ern of Leachates Dissemination in Water on a Tide Area

On a subsided area, the TDS dissemination was decreased, it was 968 mg/liter at first and then it was reduced until 438 mg/liter at the distance of 200 m. While in other parameters, the leachates dissemination pattern was occurred evenly and less likely to be decreased at the distance up to 200 m. BOD dissemination on a subsided area was evenly spread in the range of 34.31 mg/liter to 59.52 mg/liter as well as the COD dissemination which was evenly spread in the range of 293,88 mg/liter to 421,73mg/liter. Fedissemination was evenly spread in the range of 3.9 mg/liter to 13.85 mg/liter as well asthe NH_3Ndissemination in the range of 12.2 mg/liter to 47.61 mg/liter. Whereas the pH condition on a subsided area was in the range of 7.20 to 7.59. For further details about the pollutants dissemination on the subsided area, it can be seen on figure 2.

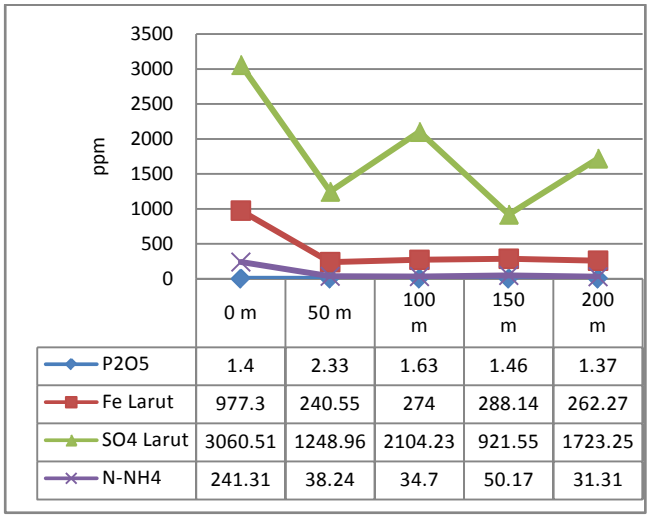
The leachates dissemination pattern of the tidal TPA was observed on soil in a tide and subsided area next to the TPA location. On a tide area, the leachates dissemination pattern was occurred evenly and less likely to be decreased at the distance up to 200 m. P_2O_5 dissemination on a tide areawas evenly spread in the range of 1.37 mg/liter up 2.33 mg/liter. SO_4 dissemination was also evenly spread in the range of 921.55 mg/liter to 3060.51 mg/liter. The Fe dissemination on a tide area was evenly spread with the range of 240.55 mg/liter to 977.3 mg/liter as well as the N-NH_4 dissemination which was spread in the range of 31.31 mg/liter to 241.31 mg/liter. Whereas the pH(H_2O) condition on a tide area was in the range of 4.34 to 4.59. For further details about the pollutants dissemination on the tide area, it can be seen on

figure 3.



	0 m	50 m	100 m	150 m	200 m
TDS	968	539	454	569	438
BOD	52.79	35.81	38.25	34.31	59.52
COD	421.73	293.88	303.52	382.34	299.84
Fe	6.23	3.9	5.12	13.85	5.39
NH3N	41.64	12.2	16.58	47.61	23.18

Figure 2. The Pattern of Leachates Dissemination in Water on a Subsided Area

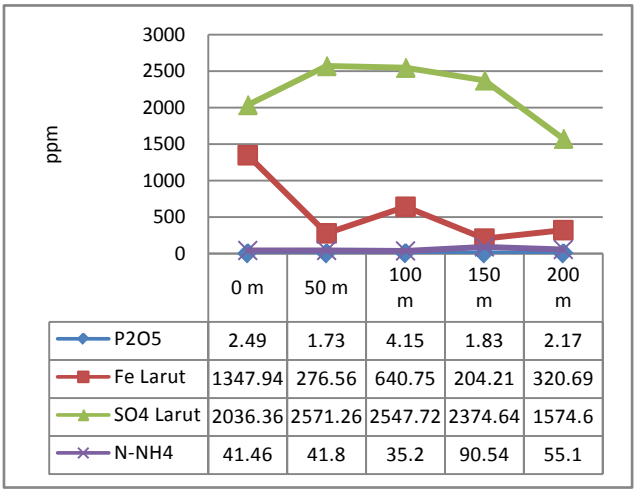


	0 m	50 m	100 m	150 m	200 m
P2O5	1.4	2.33	1.63	1.46	1.37
Fe Larut	977.3	240.55	274	288.14	262.27
SO4 Larut	3060.51	1248.96	2104.23	921.55	1723.25
N-NH4	241.31	38.24	34.7	50.17	31.31

Figure 3. The Pattern of Leachates Dissemination in Soil on a Tide Area

The leachates dissemination pattern of the tidal TPA was observed on soil in a tide and subsided area next to the TPA location. On a subsided area, the leachates dissemination pattern was occurred evenly and less likely to be decreased at the distance up to 200 m. P_2O_5 disseminationon a subsided area was evenly spread in the range of 1.73 mg/liter to 4.15 mg/liter as well as the dissemination of SO_4 in the range of 1574.6 mg/liter to 2571.6 mg/liter. Fe dissemination on a subsided area was evenly spread in the range of 204.21 mg/liter to 1347.94 mg/liter and also the N-NH_4 dissemination which was in the range of 35.2 mg/liter to 90.34 mg/liter. Whereas the condition of the pH(H_2O) in a subsided area was in the range of 3.9 to 5.06. For further details about the pollutants dissemination on the subsided area, can be seen on figure 4.

From the observation results of several water and soil quality parameter, it can be concluded that the dissemination pattern of the pollutants which caused by leachates is spread evenly/cluster. The pollutants is spread start from the distance of 0 m until 200 m, it is spread evenly without showing the reduction of pollutants concentration. This condition is caused by the TPA location which placed in a tidal area. Based on a TPA area which located in a fresh watertidal area with the type of twice overflow both large or small [7]. On a tidal area, the soil condition tends to have a large pore spaces and a full/saturated water volume [8]. The existence of the tidal area gives the direction of the ground water or surface water flow to be ups and downs on a tide or subsided condition.



	0 m	50 m	100 m	150 m	200 m
P2O5	2.49	1.73	4.15	1.83	2.17
Fe Larut	1347.94	276.56	640.75	204.21	320.69
SO4 Larut	2036.36	2571.26	2547.72	2374.64	1574.6
N-NH4	41.46	41.8	35.2	90.54	55.1

Figure 4. The Pattern of Leachates Dissemination in Soil on a Subsided Area

The contamination of ground water by leachates depends on the soil permeability which mentioned on the SK SNI that is by the passing value of< 10^{-6} cm/det or by the passing value of 10^{-6}cm/det up to 10^{-9} cm/det. If the passing value is not completed, it is required to have a technology input. Based on the laboratory results, the TPA site had a permeability of 0.52 up to 7.83 cm per hour.

The TPA soil condition on the tidal area gives an implication of a high soil porosity. High soil porosity will cause a high permeability as well as a high saturated water level. The condition of the TPA surrounding area is a turfy ground which also has its own characteristic and properties. The moisture content of the turfy ground is in the range of 100 – 1,300% of a dry weight [9]. It means that a turfy ground is able to absorb water 13 times its weight, so that a turf / moss is characterized as a hydrophilic. Thus, leachates pollutant tends to be tied on a ground at the site of tidal TPA. Their rapid groundwater flow in the area of tide and ebb implications on the speed of diffusion of pollutants leachate. This condition will spread the leachate kelingkungan quickly.

Some of the leachates pollutants parameters which spread over the TPA area could cause a disruption on the surrounding. Several pollutants parameters could harm humans and the environtment. This contamination will be more dangerous if those subtances are included as the heavy metal classification. Iron poisoning is also caused by the environmental condition which have always been flooded (reductive) with a bad drainage, so it will cause the

increasing of Fe^{+2} content as the result of Fe^{+3} reduction in the soil [10]. Generally, turfy ground has an acidity content which relatively high with the pH level of pH 3.4-5.06 like the oligotrophic turf which has a *substratum*of quartz sand in Bereng Bengkel, Center Kalimantan with the pH of 3.25 – 3.75 [11]. While the turf around water Sugihan Kiri, South Sumatera has a higher pH amount of 4.1-4.3 [12].

The dissemination of leachates pollutan on the river around TPA.

The leachates dissemination on the river around tidal TPA was observed on a tide and subsided area next to the TPA location. At the observation point of the river in a tide area, TDS concentration was ranging from 121 mg/liter up to 2183 mg/liter. BOD concentration in a tide area was evenly spread in the range of 4.02 mg/liter up to 50.25 mg/liter and the COD concentration which was in the range of 18.38 mg/liter up to 419.16 mg/liter. Fe dissemination on a tide area was evenly spread in the range of 0.6 mg/liter to 14.51 mg/liter as well as the dissemination of NH_3N which was in the range of 0.91 mg/liter up to 47.73 mg/liter. Whereas the pH condition on the tide area was ranging from 6.98 up to 7.8.

At the observation point of the river in a subsided area, the TDS concentration was ranging from105 mg/liter up to 2183 mg/liter. BOD concentration which was evenly spread in the range of 4.02 mg/liter to 50.25 mg/liter as well as the COD concentration which was ranging from 18.38 mg/liter up to 419.16 mg/liter. Fe dissemination on a subsided area was evenly spread in the range of 0.6 mg/liter to 14.51 mg/liter. NH_3N dissemination on a subsided area was evenly spread with the ranging of 0.91 mg/liter up to 47.73 mg/liter. Whereas the pH condition on a subsided area was in the range of 6.98 to 7.8. For further information, please see this table 1 below.

The pollutants which occurred in the river was caused by the human's pollution, including the tPA activities. Pollutants concentration in the river was spreading evenly in the observation of tide or subsided area.This condition is caused by the tide and subsided flow which happened continuously twice a day which resulted the even mixing of water and pollutants.

The occurrence of environmental contamination around the TPA site was because of the leachates management that was inadequate enough such as leachates isolation, leachates cultivation, and the concistency of leachates cultivation process [13] stated that the contamination will generally take place within a long period of time, for example is that there will be a contamination which came from the trash and leachates in the area around TPA. Contamination / pollution could occur in the soil, ground water or surface water and the river in the surrounding area of TPA [14]. The presence of the pollutant dissemination in the surrounding area will harm the environment and other living things [15]. Leachates quality have a high COD and BOD content. Some inorganic concentration like Fe and Ca, aligned as a result of the changes in pH. Ammonia indicated a slow enhancement with the age of TPA.In most cases, the content of heavy metals is lower than 1 mg/l [16]. According to [17] the aquatic biota is sensitive to a very acid or base pH. Neutral pH is an optimum activity of enzymes in the growth of aquatic organisms.

Therefore, there has to be a management towards the existence of leachates so it would be safe for the environment. The management can be done in the form of leachates collection, related to the leachates limitation so it would not be spread, distribution, cultivation and extrication into the environment. The main components that are necessary for the leachates management is the leachates quality and quantity, leachates cultivation methods/techniques, land availability, and the compatibility with the environmental condition [18].

Table 1. The water quality comparison of the river around tidal TPA

Observations	Water Quality of the River in Tide Area						Water Quality of the River in Subsided Area					
	TDS	pH	BOD	COD	Fe Total	NH_3-N	TDS	pH	BOD	COD	Fe Total	NH_3-N
	(mg/L)		(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)		(mg/L)	(mg/L)	(mg/L)	(mg/L)
S1	533	7.75	50.25	419.16	14.51	28.91	116	7.99	6.03	698.60	21.52	18.03
S2	209	7.04	4.02	643.3	1.1	4.38	152	7.02	3.52	422.74	1.40	2.25
S3	213	6.98	6.02	91.9	0.8	1.06	197	7.18	4.02	238.94	0.70	0.93
S4	121	7.58	7.18	18.38	3.0	47.73	105	7.41	7.05	36.76	5.50	4.77
S5	1525	7.62	9.23	177.84	0.6	2.32	1502	7.50	7.34	207.48	0.55	2.93
S6	2183	7.8	24.15	29.88	0.9	0.91	2862	7.45	14.21	19.76	0.80	1.18

Source: Primary Data.

4. Conclusions and Suggestion

Conclusions

Their rapid groundwater flow in the area of tide and ebb implications on the speed of diffusion of pollutants leachate. This condition will spread the leachate kelingkungan quickly. The content of pollutants which spread from TPA is in the distance of 0 m up to 200 m and it dissseminate evenly without showing the reduction of pollutants concentration. The even distribution of pollutant concentration occurred both in water and solid media. It is because of the TPA location which located in a tidal area and which soil with high porosity of saturated water at Peat soils. The concentraion of pollutants in the river which caused by leachates is relatively even either in a tide or subsided area.It is because of the existence of tide and subsided flow which happened continuously twice a day that caused the even mixing of water and pollutants. Implications of speed of deployment around the landfill leachate on tidal land requires landfill operators to isolate the leachate to not seep out of the landfill.

Suggestion

Observe and examine the influence of leachates pollutants in TPA towards fishes, plants and the socio-economic community on the subsequent research.

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